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Genetic variability in candidate plus trees of *Acacia nilotica* -an important fodder tree under agroforestry system

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Introduction

The realization of the effects of climate change redirected the focus on agroforestry, which deals with the management of land use system for increased sustainability. Enhancement of fodder production per unit area per unit time is essential to meet the demand from livestock sector for which different land use systems are being developed. *Acacia nilotica* is one of the important agroforestry species which fits into in silvipastoral system under agroforestry, in arid and semi-arid regions. It is known as babool, kikkar or Indian gum arabic, which has ability to improve nitrogen content of soil through its interaction with symbiotic bacteria on drought prone and degraded soils, tolerant to waterlogged conditions. It is an important source of fodder, the leaves and pods together will supplement the protein component in the livestock feed and when everything is dry; *Acacias* serve as the only green fodder source during peak summer season. It is a good source of timber, fuel wood, industrial source for the raw material tannin and as protective hedge and hence plays an important role in rural farming. The studies on maximization of forage production and wasteland development has reported that babool has highest survivability among fodder trees and has higher dry fodder production/tree/year. Tree growth and canopy diameter contributes to the production of green as well as dry fodder biomass. Assessing the variation within and among the provenance selections for different traits will help selection of genotypes for different use in the silvipastoral agroforestry system. In view of this, the present study was undertaken to study the genetic variability present in the candidate plus trees of different provenances collected from central India.

Materials and Methods

An exploration conducted in 2005, by Central Agroforestry Research Institute, Jhansi in the Central India (semi-arid regions) in four states *viz*., Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh lying between 20o 42'N to 25o 27'North latitude and 75o 39'E to 81o39'East longitude and 33 candidate plus trees were collected. 33 candidate plus trees are maintained at CAFRI Research Farm in a randomized block design with 4 replications in single row plot at spacing 5x5 m. The means of the individual replication were analyzed using systat for windows (Wilkinson et al. 1996). The phenotypic and genotypic variance, heritability and GA were worked out as suggested by various workers (Pliura *et al*., 2007; Baenziger *et al*., 2004). Diversity analysis was carried out among the candidate plus trees using SAS statistical software.

Results and Discussion

The candidate plus trees in the germplasm of CAFRI, Jhansi were studied for all the morphological characters. The coeffection of variation was low for tree height (CV-10.5) and moderate to high for all other traits ranging from 16.63 for canopy diameter to 24.12 for clean bole height. The difference between the candidate plus trees for all traits were significant statistically (table 1). The diameter at the breast height and at clean bole height also had significant difference but the clean bole height did not have significant difference among the provenance selections. All traits showed maximum for PT-1, which was selected from Lalitpur, Uttar Pradesh.

Table 1: Means of the different growth traits in *Acacia nilotica* germplasm

Candidate Plus tree code	State	TH (m)	CBH (m)	BD (cm)	DBH (cm)	DCBH (cm)	CD (m)	No of Branch
PT 1	UP	8.37	2.04	20.05	17.26	16.25	7.20	7.53
PT 2	MP	7.79	1.58	16.99	14.58	13.68	5.97	7.72
PT 3	MP	7.48	1.69	17.46	14.30	13.31	5.92	6.44
PT 4	MP	7.13	1.69	14.77	12.42	12.18	4.87	5.19

PT 5	MP	6.97	1.90	15.08	12.66	11.62	5.02	4.94
PT 6	MP	7.11	1.70	16.18	13.52	12.76	5.06	5.88
PT 7	MP	6.90	1.74	14.42	12.44	11.06	4.43	5.50
PT 8	Maharashtra	6.50	1.60	14.14	12.41	11.59	4.55	5.88
PT 9	Maharashtra	6.20	1.37	14.01	11.94	11.62	4.19	5.66
PT 10	Maharashtra	6.41	1.67	12.76	10.82	9.81	4.18	5.29
PT 11	Maharashtra	6.26	1.51	14.37	12.67	12.16	4.59	6.09
PT 12	Maharashtra	6.94	1.70	15.51	12.95	12.94	5.07	5.63
PT 13	MP	6.75	1.79	14.95	13.31	12.08	4.54	6.00
PT 14	MP	6.66	1.98	14.29	12.76	11.33	4.34	5.25
PT 15	MP	6.05	1.97	14.03	12.47	11.50	4.80	5.63
PT 16	MP	6.21	1.29	13.72	11.62	10.96	4.22	5.00
PT 17	MP	6.25	1.85	15.03	12.38	11.37	4.29	5.65
PT 18	MP	6.04	1.50	13.81	11.83	11.42	4.19	4.75
PT 19	MP	6.21	1.69	15.33	13.14	12.21	4.65	4.65
PT 20	MP	5.69	1.43	12.52	11.59	10.54	4.07	4.07
PT 21	MP	5.90	1.47	13.34	11.50	10.92	4.42	4.42
PT 22	Maharashtra	5.81	1.27	14.15	12.48	11.71	4.57	4.57
PT 23	MP	6.09	1.70	11.57	9.41	8.71	4.22	4.22
PT 24	MP	5.88	1.91	10.44	8.26	7.37	4.08	4.08
PT 25	MP	5.77	2.03	12.09	9.86	8.81	3.93	3.93
PT 26	Rajasthan	6.09	1.78	11.46	8.92	8.24	3.93	3.93
PT 27	Rajasthan	6.33	2.04	11.87	9.58	8.89	4.34	4.34
PT 28	Rajasthan	6.57	1.69	12.54	10.64	9.91	4.00	4.00
PT 29	Rajasthan	6.14	1.60	10.24	8.89	8.00	3.47	3.47
PT 30	Rajasthan	6.62	1.88	12.24	10.11	9.71	4.27	4.27
PT 31	Rajasthan	5.72	1.96	8.46	7.06	6.08	3.15	3.15
PT 32	Rajasthan	6.95	1.67	12.05	10.29	9.84	4.42	4.42
PT 33	Rajasthan	6.12	1.83	8.96	7.49	6.83	3.70	3.70
Mean		6.48	1.71	13.60	11.56	10.77	4.50	5.00
CV		10.50	24.12	16.88	16.98	19.20	16.63	20.09

The genetic variability parameters showed high phenotypic than genotypic variance indicating that environmental influence is high for these traits which is expectable in tree species. Heritability was moderate to high for all the traits except for clean bole height which was very low. This indicates that selection for genotypes based on these traits will lead to improved genotypes. The genetic advance and the genetic advance as percent of mean was low for Tree and clean bole height and moderate for all other traits.

Table 2: Estimation of genetic variables for growth traits in *Acacia nilotica* germplasm

Traits	**Range**	**Variance**		**CV**		**Heritability**	**Genetic Advance**	**GA as % of mean**
		Genotypic	**Phenotypic**	**Genotypic**	**Phenotypic**			
Tree Height	5.69-8.37	0.264	0.732	7.935	13.208	36.087	0.636	9.819
Clean Bole Height	1.27-2.04	0.003	0.171	2.925	24.158	1.466	0.012	0.730
Basal Diameter	8.46-20.05	4.366	9.645	15.365	22.838	45.264	2.896	21.295
Diameter	7.-06-	3.646	7.495	16.520	23.686	48.646	2.743	23.735

at Breast Height	17.26							
Diameter at Clean Bole Height	6.08-16.25	3.454	7.720	17.263	25.808	44.741	2.561	23.786
Canopy Diameter	3.15-7.20	0.423	0.983	14.445	22.025	43.017	0.878	19.517
No of Branch	3.15-7.72	0.895	1.908	18.907	27.604	46.915	1.335	26.678

Hierarchical cluster analysis using the Euclidean distance with UPGMA method for the morphological characters divided 33 candidate plus tree genotypes into five major groups. The cluster distance among the progenies varied form 0.2-1.4. In majority of the groups, the candidate plus trees from single state boundaries did not fall into single cluster indicating that there is variation within the boundaries. Hence selection is possible based on within and among the provenance variation. PT-14, The CPT from Indore, Madhya Pradesh did not fall into any cluster group (table.3).

Table 3: Candidate plus trees under different cluster groups

Cluster No	**No. of Accessions**	**Accession identity**	Districts & States
I	6	PT 2, PT 3, PT 12,PT 28, PT 31, PT 16	Sagar, MP; Damoh, MP; Buldhana, MH; Dausa, RJ; Jaipu, RJ; Shajapur, MP
II	1	PT 14	Indore, MP
III	13	PT 4, PT 20 , PT 5, PT 24 , PT 10 , PT 18 , PT 19 , PT 7 , PT 9 , PT 11 , PT 17 , PT 27, PT 30	Damoh, MP; Guna, MP; Jabalpur, MP; Morena, MP; Wardha, MH; Bhopal, MP; Sihore, MP; Wardha, MH; Akola, MH; Bhopal, MP; Bharatppur, RJ; Dausa, RJ
IV	8	PT 6, PT 25 , PT 29, PT 8 , PT 33 , PT 15 , PT 23 , PT 22 ,	Mandla, MP; Gwalior, MP; Dausa, RJ, Nagpur, MH; Alwar ,RJ; Indore, MP; Gwalior, MP; Nasik, MH
V	5	PT 1, PT 13 , PT 21, PT 26 , PT 32 ,	Lalithpur, UP; Khandwa, MP; Guna, MP; Dausa, RJ; Alwar, RJ

MP-Madhya Pradesh, MH-Maharashtra, RJ- Rajasthan, UP-Uttar Pradesh

Conclusion

The genetic variability studies in *Acacia nilotica* shows differences among the candidate plus tree selections for all traits contributing to the fodder yield i.e., tree height and canopy diameter. The diversity analysis indicates that the plus tree selections from Madhya Pradesh, Maharashtra and Rajasthan have large variation both within and between the geographical boundaries indicating the scope for selection for maximizing fodder biomass

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